May 1, 2006

Name: _____ Pledge (sign): _____

Env Studies 201 Test #3

Point Total: 100 pts possible

5 pts 1. Who is Lois Gibbs? Be brief (1–2 sentences).

Lois Gibbs was the president of the Love Canal Homeowners Association (LCHA) and organized the 'outer ring' residents in their (ultimately successful) demands for evacuation from the Love Canal area.

5 pts 2. **TRUE** or **FALSE** (circle one): a company can be liable for cleanup of hazardous wastes under CERCLA even if the waste disposal was legal at the time.

TRUE

5 pts 3. **TRUE** or **FALSE** (circle one): ozone depletion has caused a net global cooling. Briefly (1 sentence) justify your answer.

TRUE. Since ozone is a greenhouse gas, its depletion will cause a negative forcing (ie, a global cooling.

5 pts 4. What are the two biggest reasons for fish/shellfish consumption advisories?

High levels of mercury or PCBs, both of which bioaccumulate in organisms.

5 pts 5. Sandra Steingraber asserts that 80–90% of cancer is caused by environmental factors, a claim supported by a number of other studies. What does the term 'environmental' mean in this context?

In this context, 'environmental' means any factor that is external to the cell, which includes factors such as diet in addition to exposure to carcinogenic pollutants.

6 pts 6. What are the 'ozone precursors' that are responsible for the formation of photochemical smog? List them, as well as all the human activities that generate them.

The precursors and the activities that generate them are:

- Volatile organic compounds (VOCs), also called non-methane hydrocarbons (NMHCs) or reactive organic gases (ROGs). These are generated by fossil fuel combustion in combustion engines and power plants (released as unburned or partially burned fuel), and fugitive emissions from gasoline stations and chemical plants.
- Nitric oxide, NO (or NO_x). This is also generated by combustion processes, which are hot enough to combine nitrogen and oxygen from the air.

6 pts 7. (a) What are the main pollutants that degrade water quality? List as many as you can.

- nutrient pollution (inorganic nitrogen and phosphorus)
- pathogens
- high-BOD waste (ie, oxygen-demanding waste)
- toxic metals
- toxic organics
- siltation
- salinity
- acid pollution (acid deposition, acid mine drainage)

6 pts (b) What are the main human activities that produce these pollutants? List as many as you can.

- agricultural operations (crops and livestock)
- industrial discharges
- sewage discharges (treated, untreated, CSOs)
- urban runoff (due to increase in impervious surfaces such as roads)
- silvicultural operations (forest operations, tree harvesting)
- resource extraction (mining, drilling)
- waste disposal (eg, municipal and hazardous landfills)
- hydrologic modification (eg, dams)
- fuel transport and storage (eg oil spills, underground storage tanks)

6 pts (c) Which of these activities do you feel is the most damaging to water quality? Justify your choice, and explain how the activity causes problems.

Leading sources of degradation of US water quality are, according to EPA's 2000 National Water Quality Inventory, are:

- *Sewage discharges* for estuaries. Treated discharges usually still contain nutrient pollutants and high BOD, causing cultural eutrophication and oxygen depletion. Untreated discharges (eg from CSOs) also contain pathogens and more suspended particulates.
- *Agricultural operations* for rivers and lakes. Chemical fertilizers, livestock waste, crop residues, and pesticide application will cause a host of problems, including cultural eutrophication (from nutrient pollution), pathogens, high BOD, and toxic organic pollution.
- *Leaky underground storage tanks* cause groundwater pollution with petroleum products, as well as soil vapor problems near the leaking tank.

5 pts 8. (a) Referring to the Helsinki Protocol, Scott Barrett states that 'the acid rain game is highly asymmetric.' What does he mean by this statement?

Barrett says that the game is asymmetric because 'some countries lose if they hand in their red cards, even if all countries in the aggregate gain.' In other words, even with complete compliance with the Helsinki Protocol, there are still losers. This is different from the classic Prisoner's Dilemma gain where complete (though non-rational) compliance leads to a better condition for all, equally and collectively.

8 pts (b) Barrett was surprised by the success of the Montreal Protocol. Briefly (3–5 sentences) describe the protocol, and explain what was so surprising about its success.

The Montreal Protocol was signed in 1987 in an effort to control substances that depleted the stratospheric ozone layer. The 46 countries who signed the treaty pledged to reduce, by 1999, the production and consumption of five main CFCs to 50% of their 1986 levels. In addition the countries pledged that, by 1993, the projection and consumption of three main halons would be frozen at their 1986 levels. The treaty was designed to be flexible in order to respond to future scientific discoveries and risk assessments. For example, a number of *adjustments* to the treaty were made that accelerated the phase-out schedules of ozone depleting substances (ODSs), and further *amendments* to the treaty were signed that added new ODSs and addressed various implementation issues. The treaty also allowed developing countries to have longer phase-out schedules, and encouraged participation by restricting trade with non-parties.

By most measures, the Montreal Protocol has been very successful: participation was high and compliance has been virtually complete. This was surprising to Barrett since it seems to contradict the assumption of 'rational' behavior; somehow the treaty overcame the tendency of countries to 'free ride.' This is particularly surprising given that there was still considerable scientific uncertainty when the treaty was originally signed: although there was broad agreement that ODSs would deplete the ozone layer, the magnitude of the threat was not completely known (and estimates of the threat were actually trending downward at the time) and the cause of the recently discovered 'ozone hole' was also not known.

9. Two distinct modes of pollution regulation are *command-and-control* (CAC) and *market-based* regulation.

6 pts (a) What is CAC regulation? In your answer, be sure to state the three basic forms of CAC regulation.

Command-and-control pollution regulation occurs when some organization has the authority to enforce compliance by legal means; noncompliance with the regulation is thus against the law, and presumably will be punished accordingly. CAC is usually based on enforcing various types of standards on polluters:

- *ambient standards*, which are maximum pollution level that may be present in various environmental media (eg, water, air, soil);
- *emission standards*, which specify the maximum discharge rate of pollutants into the environment; and
- *technology standards*, which specify the methods and technology of pollution control.

6 pts (b) What is market-based regulation? In your answer, state the two basic types of incentive-based regulation.

Market-based regulation of pollution is based on forcing polluters to 'internalize' the cost of pollution. Unlike CAC regulation—which is based on negative incentives to punish polluters who break the law—market-based regulation contains positive financial incentives for polluters to reduce their pollution. Market-based methods also tend to give polluters more flexibility in determining how to reduce pollution. The two basic types of this form of regulation are

- *pollution charges and subsidies*, where polluters must either pay for each unit of pollutant discharges, or they are paid for each unit of pollutant reduction; and
- *transferable discharge permits*, where a number of discharge permits are issued that can be traded between polluters.

6 pts (c) Compare the advantages and drawbacks of these methods to regulate pollution.

Below are a number of advantages and disadvantages commonly attributed to these methods.

Command-and-control	***Market-based***
Advantages:	Advantages:
• easier to implement and monitor	• greater economic efficiency in implementation
• directly related to risk mgmt (especially ambient standards)	• (potentially) better at balancing between risks and benefits of polluting activities
• protects everyone equally (rights-based)	• less adversarial
	• applies to international problems where CAC doesn't work
Disadvantages:	Disadvantages:
• gives polluters less flexibility in how to meet standards (especially with technology forcing)	• ethical objections to utilitarianism apply
• provides no positive (financial) incentive to reduce pollution	• can lead to hot spots and environmental justice issues
	• proper 'cost' of pollution is more uncertain than estimates of health risks

Most (but not all) of the above items fall into one of three categories:

- *Economic efficiency*. Market-based methods often provide the most cost-effective methods to reduce pollution. In addition, if market forces are involved in actually setting those standards, then there is a balancing between the risks and benefits of polluting activities.
- *Individual risk-based regulation vs utilitarianism*. One feature of CAC methods is that they are more amenable to risk management and that they protect the health and welfare of every citizen equally. Even if the market-based methods lead to better economic efficiency for pollution reduction *in the aggregate*, they can also lead to pollution hot spots and the exposure of some populations to unacceptably high risks. This fact is related to 'rights-based' argument advanced by Rachel Carson and Sandra Steingraber, among others. Violation of this principle along ethnic or economic divisions can also lead to environmental justice issues.
- *Pollution monitoring and implementation*. The CAC method is generally considered to be easier to implement. The market-based method involves more extensive monitoring of pollutant sources.

Note that, in practice, CAC and market-based methods can also be 'blended' in an attempt to capture the advantages of both systems.

8 pts 10. What was the PM controversy? In your answer, be sure to elaborate on the fundamental values conflict between the opposing sides in the controversy, making the Precautionary Principle a prominent part of your answer.

In 1997 the EPA recommended new NAAQS for ozone and particulate matter, including proposing standard for a new category, $PM_{2.5}$, so-called 'fine' particulates. The EPA, which is prohibited from considering compliance costs in proposing new NAAQS, based their new PM standard largely on epidemiological data. A lawsuit was filed challenging the new standards because implementation costs were not considered, and because the PM standards were not adequately defended based on scientific grounds. The Supreme Court eventually ruled in EPA's favor, reaffirming their authority to set standards regardless of cost and asserting that EPA had acted within their discretionary scope in interpreting the scientific data.

There were two major aspects to the controversy:

- Should cost be considered in setting ambient air pollution standards?
- Was the (epidemiological) data sufficient to mandate new PM standards, including the creation of a new category of regulated substances ($PM_{2.5}$?

The answer to the first aspect is fairly straightforward: under the Clean Air Act, the EPA is legally prohibited from considering cost in setting NAAQS, which are health-based standards. Moreover, Carol Browner, EPA Administrator at the time, argues why this is the appropriate stance.

> Sensitive populations like children, the elderly and asthmatics deserve to be protected from the harmful effects of air pollution. And the American public deserves to know whether the air in its cities and counties is unsafe or not; that question should never be confused with the separate issues of how long it may take or how much it may cost to reduce pollution to safe levels. Indeed, to allow costs and related factors to influence the determination of what levels protect public health would be to mislead the American public in a very fundamental way.

The second fundamental aspect was whether the scientific evidence was sufficient to warrant revising the PM standards. Part of the problem was the strong reliance on epidemiological data: a number of studies consistently showed that there is a clear (but small) increase in health risk associated with increased levels of PM. Due to the large number of exposed population, the EPA felt that the risk of continued exposure to the current standards was too high.

But although good epidemiological studies, properly corrected for confounding factors (as much as that is possible) can show clear and consistent correlations, doubt will remain until these studies are supported by traditional clinical studies on humans and controlled toxicological studies on animals. Such studies were lacking, as was agreement on a plausible biological method of action. So there was significant scientific uncertainty remaining about both the existence and magnitude of the elevated risk of continued exposure to PM levels under the previous standards.

Basically, this is an argument about the Precautionary Principle (PP), and the level of proof that is necessary before action must be take to reduce potential risk. As stated in the Rio Declaration, the PP states that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." Again, as Browner states,

> ...because of the strong consistency and coherence across the large number of epidemiological studies conducted in many different locations, the seriousness and magnitude of the health risks, and/or the fundamental differences between "fine" and "coarse" fraction particles, [we] believed that "no action" was an inappropriate response. The question then became one of how best to deal with uncertainty—that is, how best to balance the uncertainties with the need to protect public health.

Browner basically buys into the Precautionary Principle: that even in the absence of complete scientific 'proof,' steps must be taken to protect public health.

Daniel Menzel, on the other hand, insisted on a higher level of proof. He feels that the health benefits must be more certain before costly action should be taken. Otherwise, new standards could be set arbitrarily and be implemented at great cost to no effect; enough of this behavior and the public would lose faith in the ability of public agencies to assess and regulate the health risk due to pollution.

12 pts 11. Choose ONE of the following and answer.

(a) In some detail, explain how toxicological and epidemiological data can be used to set 'health-based' ambient pollution standards. In your answer, be sure to explain the NOAEL and explain its importance in setting health-based standards.

- animal studies. Controlled dose-response. Explain this concept. Include a figure showing the NOAEL, and explain it too. Explain how it is determined (from extrapolation). Problems.
- Setting ambient pollutant standards based on health risk, using the NOAEL. 'Adequate margin of safety' is supposed to account for the effects of scientific uncertainty and the effect on sensitive populations. Usually 100-fold for animal studies: 10X for interspecies problems and other sources of scientific uncertainty, 10X for sensitive populations.
- setting levels for pollutants with no threshold level: minimize risk.
- epidemiological studies. Types and strengths.

(b) Health-based pollution standards are sometimes criticized on an economic basis. What is the nature of this criticism? How is it justified on ethical grounds? How would defenders of health-based standards reply to such criticism?

Criticisms:

- ignores benefits associates with the activities that produce pollutants. Ethical component: utilitarianism. Could increase the price of required goods and services (eg, food) and cause hardship.
- not economically efficient. Doesn't lead to a Pareto Optimum. Ethical component: utilitarianism.

Responses

- right to a pollutant-free environment (or at least to reduce risk to 'natural' levels)
- difficulty in assigning a price to human health (involuntary or even unknowing component of exposure)
- environmental justice issues
- biocentric arguments